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Research Article

Use of Water-Saving Agricultural Practices in Imo State, Nigeria

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Abstract

The study examined the use of water-saving agricultural practices in Imo State, Nigeria. The specific objectives were identification of the agricultural activities, ascertainment of perceived causes of water scarcity, determination of the severity of water scarcity, identification of effects of water scarcity on agricultural production, ascertainment of water-saving agricultural practices used and identification of challenges to the use of the practices. A sample of 120 rural farmers selected using multistage sampling procedure participated in the study. Data were collected using interview schedule and analyzed using mean and percentages. The hypothesis was tested using multiple regression model. The result showed that population growth (94.2%), dilapidation of water infrastructure (83.3%), climate change (82.5%) and water pollution (75.8%) were the perceived causes of water scarcity by the farmers. About 41.0% of the farmers perceived water scarcity to be severe while 23% perceived it as not severe. Water scarcity was perceived to cause loss of agricultural crops and livestock (92.5%), violent conflicts (81.7%), decrease in soil fertility (80.3%) and not planting all year round (80.3%). Agricultural water-saving practices used by the farmers included growing water-efficient crops ($\bar{x}$ =3.2), planting crops in mounds ($\bar{x}$ =3.0), planting cover crops ($\bar{x}$=2.8) and harvesting rainwater ($\bar{x}$ =2.8). Challenges to the use of water-saving practices were poor government support ($\bar{x}$ =3.0), environmental factors ($\bar{x}$ =2.8), lack of infrastructure ($\bar{x}$ =2.8) and poor access to extension service ($\bar{x}$ =2.7). The multiple regression result showed that at $p < 0.05$ significance level, F-value of 8.4 and R^2 value of 0.65, sex (t = 3.8, p = 0.03), farming experience (t = 3.8, p = 0.01) and annual income (t = 2.2, p = 0.05) influenced the use of water-saving agricultural practices. It was recommended that government should improve on its support to agriculture.

Keywords: Socioeconomic factors; Determinants; Use; Water-saving practices; Agriculture; Rural farmers; Climate change

Background of the Study

FAO Aquastat [1] reported a 55% drop in the globally available fresh water per capita since 1960. By 2030, global demand for water is expected to grow by 50% (United Nations, n.d.). Furthermore, by 2050, an additional 2.3 billion people are expected to be living in areas with severe water stress particularly in Africa (OECD, 2012). However, 70% more food will be needed by (2050) (FAO, 2009). Climate change projections suggest that water scarcity will be more severe in the future [2]. According to [1] agriculture is the largest user of water, consuming about 70% of the total water withdrawals which is equivalent to 2700km3/year.

The majority of developing countries have shortage of renewable freshwater resources [3]. The sub-Saharan African region is the most vulnerable because of the high reliance on rainfed agriculture (95%), an enormous lack of access to clean water (340 million people) and fragile institutions (Steinfeld, 2019). According to [4] a one-standard deviation decreases in the values of a drought index (drier conditions) might increase the probability of riots by 8.3% in this region. According to [5] the shrinking of the Lake Chad basin and erratic rainfall evidence the growing scarcity of fresh water in Nigeria. This is expected to induce migration of humans and animals, conflicts and general reduction in agricultural production. However, this will have particularly high impact on rural households whose vulnerability is exacerbated by their low income, lack of resources, inadequacy of social amenities and reliance on agriculture.

Guppy and Anderson [6] argued that enhanced water security can stabilize food production and prices. This can be achieved through the use of water-saving techniques. According to [7] many resource-conservation technologies like minimum tillage, no/zero tillage, direct seeding, bed planting and alternate wetting and drying have been developed and practiced over the decades globally. They save water by reducing water application in the fields with resulting lower percolation and groundwater recharge [8]. For example, the alternate wetting and drying (AWD) method saves between 15% and 60% of water compared to continuous standing water rice system [9,10] reported that mulching optimizes water use.

Adoption of improved agricultural technologies have been associated with higher earnings and reduced poverty, improved nutritional status, lower staple food prices, increase in employment opportunities as well as earnings for landless laborer's [11] stated that agricultural technology embodies a number of important characteristics that may influence adoption decisions. Akudugu [12] classified the determinants of adoption of agricultural technologies into social, economic and physical factors. Mwangi and Kariuki [13] reported a positive relationship between farm size and adoption of agricultural technology. Sennuga [11] found that access to agricultural information enhanced the adoption of agricultural technology. While there is a growing need for efficient water utilization especially in agriculture, studies are scarce on water-saving practices used by rural farmers in Imo State, Nigeria. This scarcity affects the availability of evidence-based information for policy. To fill this gap, the study sought to provide answers to the following research questions: what are the agricultural activities of the farmers? What are the farmers' perceived causes of water scarcity? How do the farmers perceive water scarcity? What practices do they use in coping with water scarcity? And what challenges do they face in using water-saving practices.

Objectives of the Study

The broad objective of the study was to examine on-farm water-saving agricultural practices used by farmers in Imo State, Nigeria. Specifically, the study identified agricultural activities of the farmers, ascertained perceived causes of water scarcity by the farmers, determined the severity of water scarcity, identified the effects of water scarcity on agricultural production, identified on-farm water-saving practices used by the farmers and determined challenges to the use of the practices.

Hypothesis

The socioeconomic characteristics of the farmers did not influence the use of water-saving agricultural practices in their farms.

Materials and Method

The study was conducted in Imo State, Nigeria. Imo State is located within latitudes 4 °45'N and 7 °15'N and longitudes 6 °50'E and 7 °25'E with an area of about 5,100 km2 (https://en.wikipedia.org/wiki/Imo_State.). The state is bounded in the east by Abia State, in the west by River Niger and Delta State, in the south by Rivers State and north by Anambra State. Farming is the major occupation of the people. The prominence of agriculture as a major occupation of the inhabitants of the state makes it vulnerable to the impacts of climate change. In Nigeria, Dagash (2018) reported that land use accounts for 52% of greenhouse gas emission and is largely contributed by deforestation and agriculture. Climate change has altered the frequency of precipitation and drought in many parts of the country including Imo State. This is demonstrated by the decreasing crop yields.

The population for the study comprised all farmers in the state. The sample was selected using multistage sampling technique. From each of the three agricultural zones of the state – Orlu, Okigwe and Owerri, two local government areas were selected using purposive sampling technique. The local governments were Orlu and Ideato North local government areas in Orlu zone, Ikeduru and Isiala Mbano in Okigwe zone and Aboh Mbaise and Ngor Okpala in Owerri Zone. This was done to ensure the selection of areas prone to water scarcity. In the next stage, two communities were selected from each of the local governments using simple random sampling technique. The communities were Ibeme and Amaraku from Isiala Mbano LGA, Iho and Inyishi from Ikeduru LGA, Amaifeke and Eziachi from Orlu LGA, Akokwa and Obodoukwu from Ideato North LGA, Obiangwu and Umuekelem from Ngor Okpala LGA and Enyiogugu and Okwuato from Aboh Mbaise LGA. In the third stage, 10 farmers were selected from each of the selected communities using snowball sampling technique. A total of 120 farmers participated in the study.

Agricultural activities were measured by listing possible agricultural activities and asking farmers to indicate the ones they engaged in. Causes of water scarcity were identified by listing conditions that could lead to that and asking the farmers to indicate the ones they perceived as causes. The severity of water scarcity was measured on a nominal scale of 'very severe', 'moderately severe', 'severe' and 'not severe'. Effects of water scarcity on agricultural production was measured by providing a list of likely effects of water scarcity on agriculture and requesting the farmers to indicate the ones applicable to them. Water-saving practices used by the farmers were measured on 3-point Likert type scale of 3 = highly used, 2 = used and 1 = not used. The mean of the scale was obtained by summing the values assigned to the scale and dividing by the number of scales to obtain a discriminating index of 2.0. Thus, any item with $\bar{x} > 2.0$ was taken as a practice used by the farmers. Challenges to the use of water-saving practices was measured on 3-point Likert type scale of 3 = very serious, 2 = serious and 1 = not serious. The mean of the scale was obtained by summing the values assigned to the scale and dividing by the number of scales to obtain a discriminating index of 2.0. Thus, any item with $\bar{x} > 2.0$ was taken as a challenge to use of water-saving practices.

Data for the study were collected using interview schedule and were analyzed using mean score and percentages. The hypothesis was tested using multiple regression model expressed as:

$$Y = f(X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8 + e)$$

where:

Y = Use of water-saving technologies (measured on 3-point Likert type scale of highly used = 3, used = 2 and not used = 1)

X_1 = Age (Years)

X_2 = Sex (Male = 1, Female = 0)

X_3 = Educational level (educated = 1, uneducated = 0)

X_4 = Marital status (married = 1, unmarried = 0)

X_5 = Farming experience (Years)

X_6 = Household size (No. of persons/household)

X_7 = Annual income (N/Year)

X_8 = Membership of social organizations (Member = 1, non-member = 0)

e = error term

Results and Discussion

Socioeconomic characteristics of the farmers

Table 1 shows that a greater proportion (45.8%) of the farmers were aged between 20 – 49 years followed by 43.3% whose ages were above 50 years. The mean age was 53.1 years. This suggests that the agricultural workforce in the study area is ageing. Absence of young people in farming has serious consequences for food security. For example, agriculture is still rudimentary and relies mostly on the use of human power in most parts of Nigeria. Thus, aged farmers might lack the physical strength required for increased food production. Also, age has been reported by many studies to influence the adoption of technologies [14]. Aged farmers are sometimes hesitant to adopt innovations.

Table 1: Distribution of farmers by socioeconomic characteristics.

Socioeconomic Variables	F	%	$\bar{x}$
Age (Years)			
< 20	13	10.8	
20 – 49	55	45.8	53.1
> 50	52	43.3	
Sex			
Male	50	41.6	
Female	70	58.3	
Marital Status			
Single	17	14.2	
Married	81	67.5	
Separated	10	8.3	
Divorced	12	10	
Educational Qualification			
No formal education	13	10.8	
Non-formal education	7	5.8	
Primary school	11	9.2	
Secondary school	79	65.8	
Tertiary education	10	8.3	
Income Level (N/Year)			
< 100,000	23	19.1	
100,000 – 500,000	60	50	600,000
> 500,000	37	30.8	
Social Organization Membership			
None	5	4.2	
1 - 5	67	55.8	8
> 5	48	40	

Farming Experience (Years)			
1 – 5	12	10	
6 – 10	67	55.3	15.6
> 10	41	34.2	

Source: Field Survey Data, 2021

The result showed that most (67.5%) of the farmers were married. Marriage could raise the need for increased food production. A household that engages in agriculture at the subsistence level may have the need to increase food production so as to secure the household's food security. For market-oriented production, marriage can serve as a source of farm labour which will help minimize production cost. These two situations can promote the use of water-saving agricultural practices as a way of boosting agricultural yield and income.

Educational qualification of the farmers showed that the majority (65.8%) acquired secondary education whereas 10.8% had no formal education and 9.2% received primary school education. Acquisition of education enhances decision making. Educated farmers are more likely to adopt efficient agricultural practices than their uneducated counterparts.

The result also showed that most (80.8%) of the farmers earned above the minimum wage in Nigeria. This showcases the lucrativeness of agriculture in the area. Many studies [15,16] have reported the growing shift away from agriculture-related businesses by people particularly the youths in Nigeria. Aphunu and Akpobasa [15] reported that young people perceived agriculture as stressful and meant for less privileged people. This finding however contradicts the report of [17] which found that youths are positively inclined towards agriculture.

It was further revealed that a large majority (95.8%) of the farmers were members of social organizations. The average number of organizations they belonged to was eight. Membership of social organizations is a social capital. According to [18] social capital plays the role of information flow which could enhance the adoption process. Pannell [19] described adoption as a learning which involves the accumulation of information and acquisition of skills. Micheels and Nolan [18] found a positive correlation between farmer's social capital and adoption of agricultural technologies.

The result showed that most (55.3%) of the farmers had been in the business of farming for 6 – 10 years while 34.2% had farmed for over 10 years. The farmers have farmed for an average of about 16 years. It can be inferred from this result that the farmers have in the business of farming for a reasonable length of time.

Agricultural activities of the farmers

Figure 1 shows that crop production (91.0%), agro-produce sale (81.0%), livestock production (78.0%) and agro-processing (56.0%) were the major agricultural activities the farmers participated in. The result suggests diversification of agricultural enterprises by the farmers perhaps to adapt to water scarcity. The involvement in many agricultural enterprises would reduce the risks farmers are exposed to as a result of water scarcity. FAO [20] stated that by diversifying, farmers increase the range of potential food and income sources available to them. Waha and McCord [21,22] stated that by increasing the range of agricultural products for markets or subsistence, farmers cope with the effects of climate change.

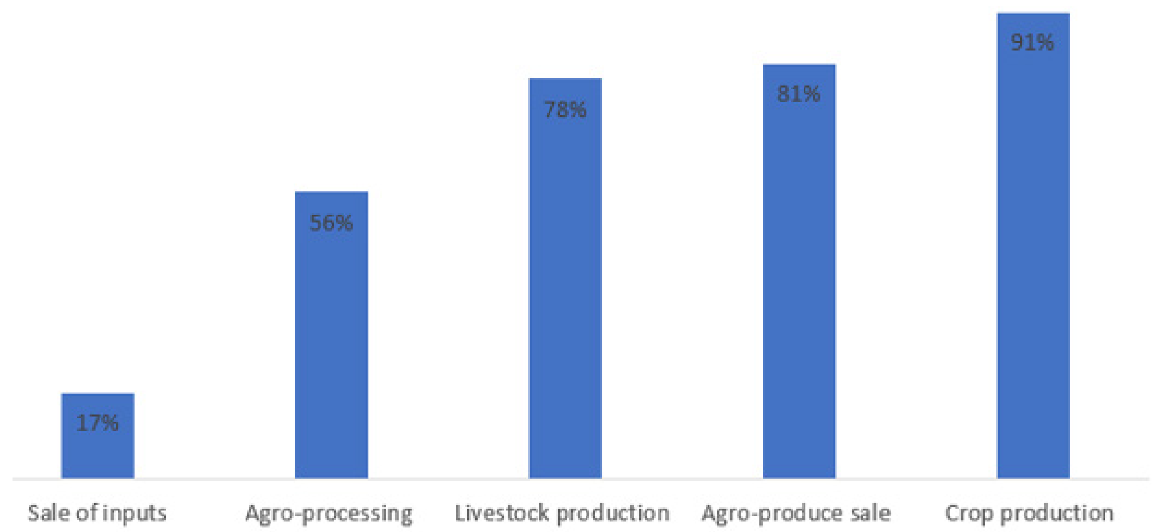

Figure 1: Agricultural activities of the farmers.

Farmers' perceived causes of water scarcity

Table 2 shows that the farmers described water scarcity as being caused by many factors. The major factors however included population growth (94.2%), dilapidation of water infrastructure (83.3%), climate change (82.5%) and water pollution (75.8%). This suggests that the causes were mainly man-made. Zhou [23] confirmed the effects of human activities on the environment. According to Luo and Zhang the impacts of human activities on natural ecosystem are particularly serious in arid areas where landscape ecology is very fragile due to limited water resources. Jimoh and Ifabiyi [24] reported that bush burning, deforestation, overgrazing, burning of fossil fuels and air pollution have caused heavy rainfall or flooding, high air temperature and warm wet climate.

Table 2: Farmers' Perceived causes of water scarcity.

Causes of Water Scarcity	F	%(*)	Ranking
Siltation of water bodies	23	19.2	12th
Rapid urbanization	56	46.6	11th
Depletion of freshwater resources	65	54.2	10th
Salinization	67	55.8	9th
Depletion of ground water	76	63.3	8th
Expansion of agricultural and industrial use	81	67.5	7th
Water pollution	91	75.8	6th
Climate change	99	82.5	5th
Variation in rainfall pattern	99	82.5	4th
Dilapidation of water infrastructure	100	83.3	3rd
Population growth	113	94.2	2nd
Drought	117	97.5	1st

Source: Field Survey Data, 2021

*Multiple response

Severity of water scarcity

Result in Figure 2 shows that most (41.0%) of the farmers described water scarcity as being severe, 23% indicated that it is not severe while 16% described it as being very severe. This shows varying perceptions of water scarcity by the farmers. However, the description of water scarcity by a large proportion of the farmers suggests negative implications for agriculture. Olalekan [14] stated that the world is running out of clean and fresh water to feed and nourish the increasing global population. Ringler [25] reported that nearly 2.4 billion people which is more than one-third of the world's current population live in regions with scarcity of water and projections indicate that by 2050 more than half of the global population could be at risk of water stress. Olalekan [26] noted that overexploitation of water resource as a result of the rising population and rapid economic development mounts pressure on water availability.

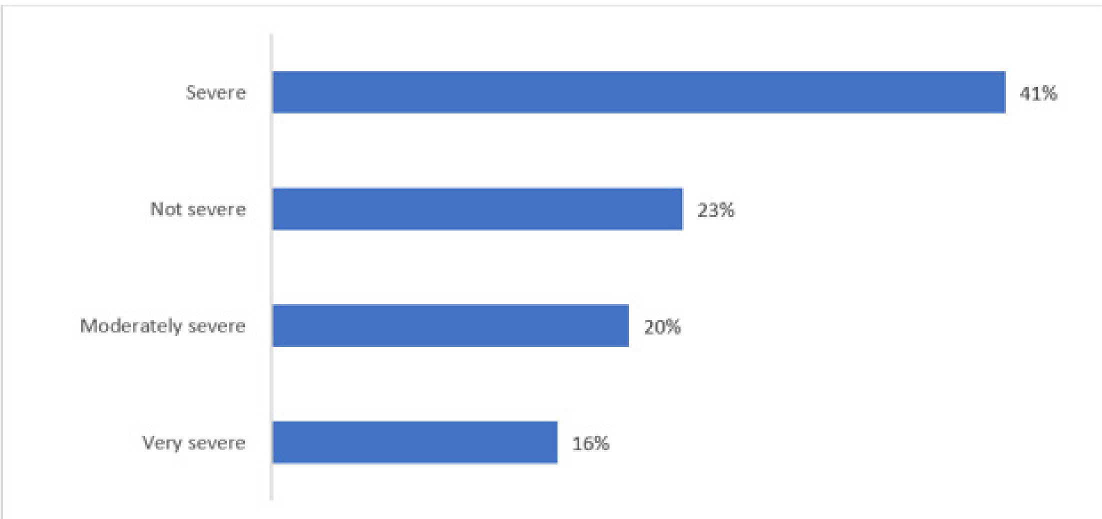

Figure 2: Severity of water scarcity.

Effects of water scarcity on agriculture

Table 3 shows that loss of agricultural crops and livestock (92.5%), violent clashes (81.7%), not planting all year round (80.0%) and reduced crop yield were the major effects of water scarcity on agriculture as perceived by the farmers. Musse found that water scarcity reduced crop yields, reduced soil fertility, caused weight loss and increase in animal death, formation of hardpans and sale of livestock as a buffer in Uganda. Khan [3] found that water scarcity reduced the productivity of some water-intensive crops like sugar cane, rice, and cotton in Pakistan. In, Nigeria, the drying of the Lake Chad Basin and other inland waters has led to a drastic reduction in agricultural yields and migration of animals and humans and in most cases violent clashes over natural resources. In the southern part of Nigeria, many cases of water-related conflicts have been recorded. It is estimated that in the next 25 years, water will remain the source of conflict in Nigeria as many countries it shares water resources with will continue to struggle for the scarce resource [14]. Aromolaran [27] confirms that water scarcity had effects on rural livelihoods in Ogun State, Nigeria. According to them, the types crops grown, the farming system practiced and water quantity available for fish farming.

Table 3: Effects of water scarcity on agriculture.

Effects of water scarcity on agriculture	F(*)	%	Ranking
Reduction in milk production	23	19.2	12th
Migration of animals	34	28.3	11th
Reduction in egg production	56	46.7	10th
Changes in labour	78	65	9th
High cost of production	79	65.8	8th
Delayed planting	89	74.2	7th
Disease infestation	91	75.8	6th
Reduced crop yield	93	77.5	5th
Not planting all year round	96	80	4th
Decreases in soil fertility	97	80.3	3rd
Violent clashes	98	81.7	2nd
Loss of agricultural crops & livestock	111	92.5	1st

Source: Field Survey Data, 2021

*Multiple response

Water-saving practices used by the farmers

Table 4 shows the diversity of water-saving practices used by the farmers. According to the result, they used several practices but to varying degrees. The mostly used included planting of early maturing crops ($\bar{x}$ = 3.5, S.D = 0.5), growing water-efficient crops ($\bar{x}$ =3.2,S.D.=0.4), growing crops in mounds of debris buried in soil ($\bar{x}$ = 3.0, S.D. = 0.1), mulching ($\bar{x}$ = 3.0, S.D = 0.7), regular weeding ($\bar{x}$ = 3.0, S.D = 0.2), construction of pits ($\bar{x}$ = 2.9. S.D = 0.4), planting drought-resistant crops ($\bar{x}$ = 2.9, S.D. = 1.0) and planting cover crops ($\bar{x}$ = 2.6, S.D. = 0.8). The use of several practices may be explained by the fact that one practice may not fit all situations. Also, the combination of practices increases effectiveness. However, the result implies that the farmers are using simple and cost-effective practices to cope with water scarcity in their agricultural enterprises. Their simplicity and affordability can encourage use. Farmers' perceptions might be responsible for the high use of some practices more than the others. According to [28] farmers' perception influences their adoption decision. Compatibility of a technology or practice is an important factor in the adoption decision. Cooper and Zmud [8] argued that if an innovation is compatible with current practices and infrastructure, its adoption is more likely. Also, the compatibility of a practice with the environment can facilitate its adoption.

Table 4: Water-saving practices used by the farmers.

Water-Saving Practices Used	F	%	Ranking
Reduced tillage	2.5*	0.7	8th
Subsoiling (loosens topsoil to promote tillage)	1.6	0.5	
Zero or no tillage	1	0.1	
Terraces	2.0*	0.9	10th
Flood water harvesting	2.8*	0.2	5th
Underground storage	2.1*	0.2	9th
Surface storage	2.6*	0.2	7th
Delineation of natural depressions	1.5	0.3	

Construction of pits	2.9*	0.4	4th
Construction of stone bunds	1.2	0.7	
Growing crops in mounds of debris buried in soils	3.0*	0.1	3rd
Growing water-efficient crops	3.2*	0.4	2nd
Planting cover crops	2.8*	0.6	5th
Planting along river basins	1	0.8	
Planting early maturing crops	3.5*	0.5	1st
Mulching	3.0*	0.7	3rd
Planting on ridges and beds	2.6*	1	7th
Planting drought-resistant crop varieties	2.9*	1	4th
Regular weeding	3.0*	0.2	3rd
Planting under tall trees that have canopies	2.7*	0.9	6th

Source: Field Survey Data, 2021

*Water-saving practices used

Challenges to use of water-saving practices

Figure 3 shows that several challenges constrained the use of water-saving technologies by the farmers. High ranking challenges included poor government support (92%), poor access to extension service (91%), inadequacy of infrastructure (84%), poverty (83%) and environmental factors (79%). It could be inferred from the result that the challenges to the use of water-saving practices in the area are mostly institutional. This portrays the inadequacy of Nigerian government's supports and investments towards boosting local agricultural production. This can be blamed on the failure or incompetency of the organizations saddled with these responsibilities. Owolabi [29] reported low extension coverage in Kaduna State, Nigeria. Genius [30] asserted that access to timely agricultural information is useful for technology adoption. The presence of supporting infrastructure facilitates the adoption of agricultural technologies. They maintained that though other infrastructure is important, but irrigation is highly important because of the growing cases of climate change-induced water scarcity. It is projected that by 2030 about 80% of future production gains will be made from intensification of irrigation infrastructure [31]. Lack of resources both human and financial influence the adoption of technologies [32,33] stated that low-costs technologies are easily adopted unlike capital-intensive technologies. This is more important in rural settings where most of the farmers are resource-poor.

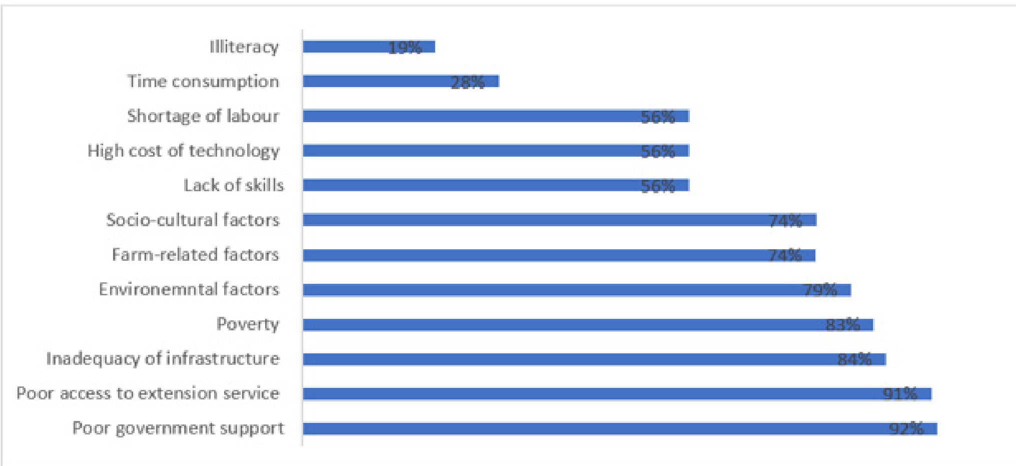

Figure 3: Challenges to use of water-saving practices.

Multiple regression result showing relationship between socioeconomic characteristics and use of water-saving technologies

Table 5 shows that at $p < 0.05$, R2 value of 0.65 and F-value of 8.40, the socioeconomic characteristics of the farmers accounted for 65% of the variations in their use of water-saving practices. The socioeconomic variables that were significant included age (t = 1.93, p-value = 0.02), sex (t = 2.97, p-value = 0.03), marital status (t = 2.65, p-value = 0.04), household size (t = 2.18, p-value = 0.05) and annual income (t = 1.97, p-value = 0.04). Issa [34] many studies have confirmed the influence of socioeconomic factors on adoption of agricultural technologies [34-36]. According to them, these factors could have positive or negative influence on the adoption of agricultural technologies. Issa [34] found that age and farm size influenced the adoption of improved maize production practices in Kaduna State, Nigeria.

Table 5: Regression table showing relationship between socioeconomic characteristics and use of water-saving practices.

Variables	Std. Coeff. Beta	t	Sig.
Constant		2.02	0.32
Age	0.06	1.93*	0.02
Sex	0.05	2.97*	0.03
Educational level	2.87	3.45	0.92
Marital status	0.57	2.65*	0.04
Farming experience	0.34	3.45	0.89
Household size	0.78	2.18*	0.05
Annual income	0.45	1.97*	0.04
Social organization membership	0.65	3.65	0.6

$P < 0.05$, $R2 = 0.65$, Fvalue = 8.40

Source: Field Survey Data, 2021

Conclusion

This study has established that water scarcity is a threat to agricultural production in the study area. In response to this, the farmers used several water-saving technologies to sustain their agricultural production. However, the farmers grappled with mainly challenges which were many institutional. The study also established that socioeconomic factors influenced their use of the water-saving practices.

Recommendations

Based on the findings of the study, the following recommendations were made:

- The governments at all levels should step up their support for agricultural development in the country. This can be achieved through the formulation and implementation of effective agricultural policies and programmes.
- The public extension system should be revived. This can be achieved by increasing the funding, budgetary allocation to agriculture and the regular training of extension staff. More so, the emoluments of extension staff should be increased so as to motivate extension staff and promote the interest of young people in the job. Modern ICT tools should as well be fully integrated in extension service delivery so as to enhance, reach, spread and timeliness of information disseminated.
- Innovative approaches such the private public partnership should be harnessed in reviving the dilapidated infrastructural facilities in rural areas. This should pay more attention to water-related infrastructure because of their relevance in agricultural production.
- Routine skill enhancement programmes should be organized for local farmers on the use of
- water-saving technologies. This will improve the skill of farmers on these practices.
- Water-saving practices introduced to the farmers should be aligned to their socioeconomic characteristics. This is to their adoption by the farmers.

Acknowledgement

None.

Conflict of Interest

No conflict of interest.

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